OPERATING AND SERVICING MANUAL

FOR

SPECIFICATION H07 425A

DC VOLTMETER

(Serials 002-02451 and above)

Specification H07-425A is similar to the standard Hewlett-Packard Model 425A Microvolt-Ammeter. It has been modified extensively for a specific application.

1. The instrument is supplied without cabinet, panel, meter, INPUT connector, probe assembly, or power switch.

2. All CURRENT ranges have been eliminated.

3. The following end scale voltage ranges are available: 10, 30, and 100 microvolts, 0.3, 1, 3, 10, and 30 millivolts, 0.1, 0.3, 1, 3, 10, 30, 100, 300, and 1000 volts. The attached schematic illustrates the special circuitry required to cover these ranges.

In all other respects the information in the standard Operating and Servicing Manual applies to these special instruments.

-----NOTE-----

There may be minor discrepancies between your instrument and the attached special schematic. Always check the attached standard manual for the latest values on all components that have circuit references assigned.

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1501 PAGE MILL ROAD, PALO ALTO, CALIFORNIA, U.S.A.

SPECIFICATIONS

VOLTMETER

Voltage Range:
Positive and negative voltages from 10 microvolt end scale to 1 volt end scale in an eleven step, 1, 3, 10 sequence.

Accuracy:
Within ±3% of end scale. Power line frequency variations of ±5 cps affect accuracy less than 2%.

Input Impedance: 1 megohm ±3%.

MICROAMMETER

Current Range:
Positive and negative currents from 10 picoamperes (pa) end scale to 3 milliamperes end scale in an eighteen step, 1, 3, 10 sequence.

Accuracy:
Within ±3% of end scale. Power line frequency variations of ±5 cps affect accuracy less than ±2%.

Input Impedance:
Depends on range, 1 megohm to 0.33 ohm.

Range	Impedance
10 pa (μμa)	1.000 megohm
30 pa	1.000 megohm
100 pa	1.000 megohm
.3 na (m μa)	1.000 megohm
1 na	1.000 megohm
3 na	0.333 megohm
10 na	0.100 megohm
30 na	0.033 megohm
.1 μa	0.010 megohm
.3 μa	3300 ohms
1 μa	1000 ohms
.003 ma	333 ohms
.01 ma	100 ohms
.03 ma	33 ohms
.1 ma	10 ohms
.3 ma	3.3 ohms
1 ma	1.0 ohm
3 ma	0.33 ohm

AMPLIFIER

Gain: 100,000 maximum.

AC Rejection:
At least 3 db at 0.2 cps, 50 db at 50 cps and approximately 60 db or more above 60 cps. A power line or twice power line frequency signal 40 db greater than end scale causes less than 1% error.

AMPLIFIER Cont'd

Output:
0 to 1 volt for end scale reading, adjustable (5000 ohm shunt potentiometer) 1 ma maximum at 1 volt output.

Output Impedance:
Depends on setting of output potentiometer; 10 ohms when potentiometer is set for maximum output.

Noise:
Less than 0.2 μv rms (typically less than 1.2 μv peak-to-peak) referred to the input.

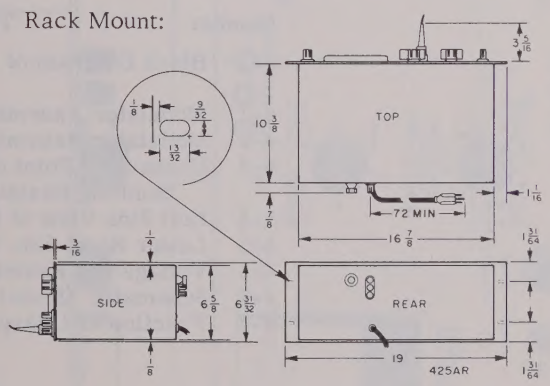
Drift:
After 15 minutes warm-up, drift is less than ±4 μv per day referred to the input.

GENERAL

Power:
115/230 volts ±10%, 60 cps, 40 watts.
50 cycle operation also available.

Dimensions:
Cabinet Mount: 7-3/8 inches wide, 11-3/4 inches high, 12 inches deep.

Rack Mount:



Weight:
Cabinet Mount: Net 17 lbs, shipping 23 lbs.
Rack Mount: Net 21 lbs, shipping 33 lbs.

Accessory Available:
425A-21B 1000:1 Divider Probe increases range of 425A to 1000 volts. Division accuracy ±2%, input resistance 10 megohms.

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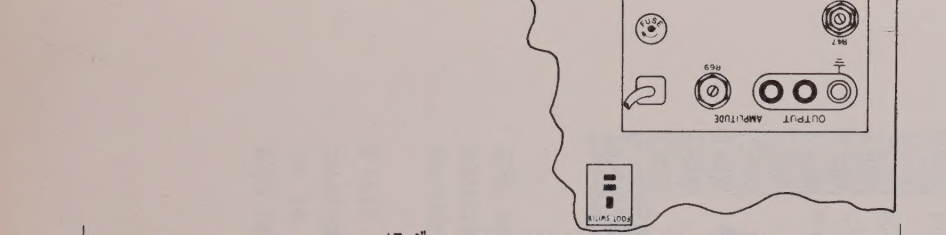
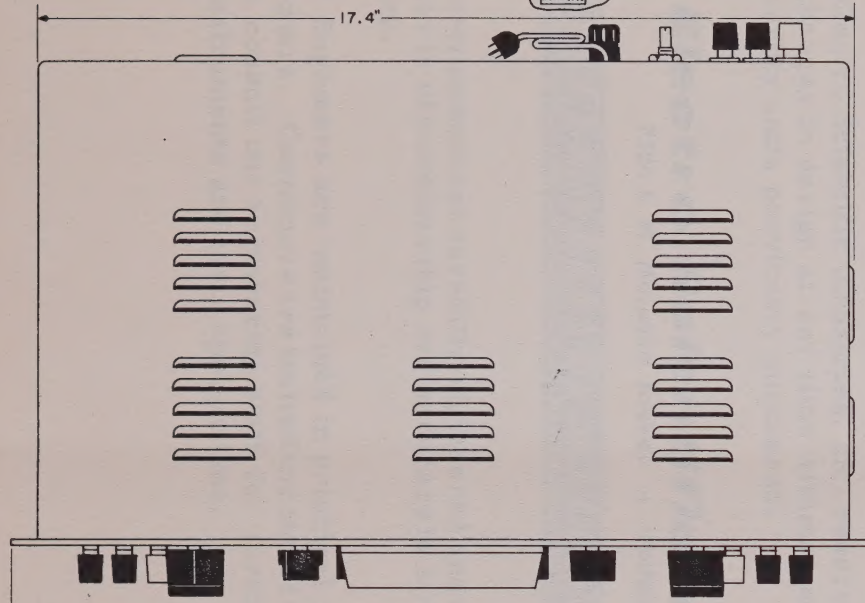
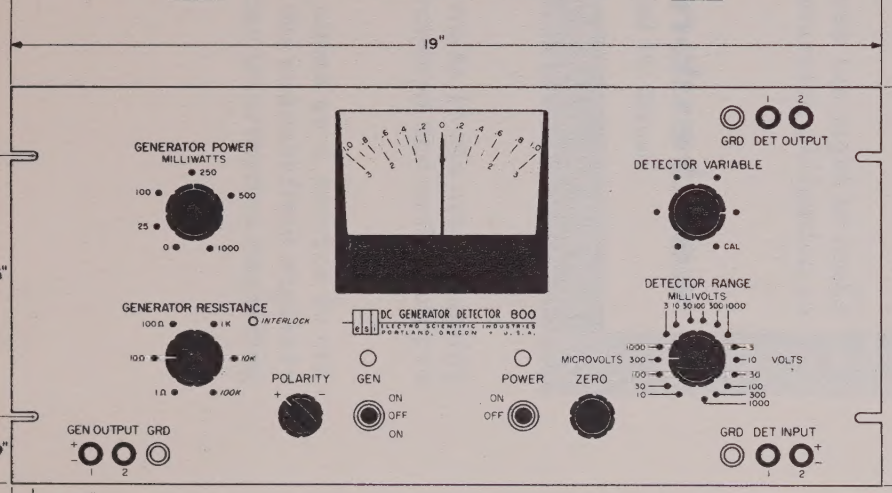
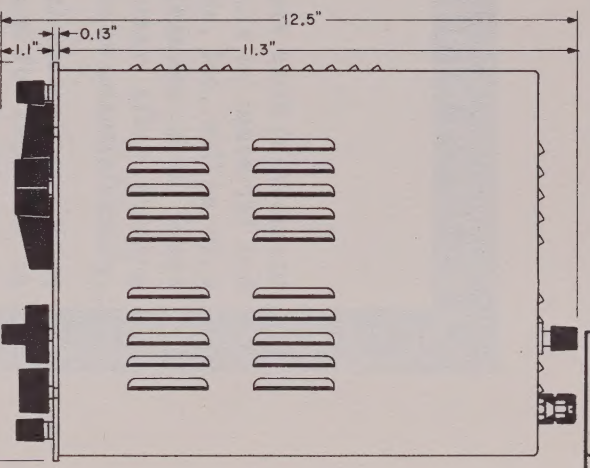
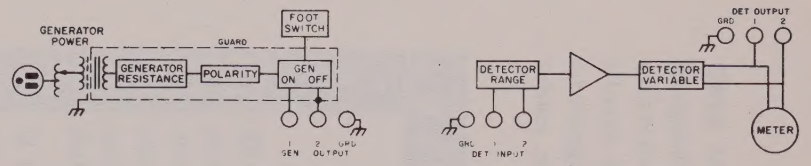








CIRCUIT SCHEMATIC



SPECIFICATIONS

GENERATOR

RANGE SWITCH: 6 POSITIONS WITH SAFETY INTERLOCK ON 200 V AND 600 V RANGES
OUTPUT CONTROL: CONTINUOUSLY VARIABLE FROM 0 TO 1000 mw INTO MATCHED LOAD
LEAKAGE RESISTANCE: TERMINAL 1 GREATER THAN 10^{14} OHMS. TERMINAL 2 GREATER THAN 10^{11} OHMS

DETECTOR

VOLTAGE RANGE: 0 TO 1000 VOLTS. 0.2 MICROVOLTS PER DIVISION ON LOWEST RANGE
HUM REJECTION: APPROXIMATELY 60 db AT 60cps
INPUT RESISTANCE: 1.2 MEGOHMS
OUTPUT VOLTAGE: APPROXIMATELY 1 VOLT MAX FOR FULL SCALE
OUTPUT RESISTANCE: 0 TO 2500 OHMS DEPENDING ON OUTPUT SETTING

WEIGHT: 35 LBS NET. 55LBS PACKED FOR SHIPMENT

model 800

AUGUST 1960

esi *Outline Drawing*

Electro Scientific Industries

DC GENERATOR DETECTOR

model 800

CLAIM FOR DAMAGE IN SHIPMENT

This instrument should be tested upon receipt. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be forwarded to us by the claim agent. We will then advise you of the disposition to be made and arrange for repair or replacement. Include model and serial number when referring to this instrument.

WARRANTY

Electro Scientific Industries, Inc. warrants each instrument and component parts to be free from defects in material and workmanship. Electro Scientific Industries, Inc. will service any instrument and replace parts thereof (except tubes, fuses and batteries) which shall, within one year after making delivery to the original purchaser, prove to be unsatisfactory.

If the fault has been caused by misuse or abnormal conditions or operation, a nominal charge will be made for repairs. In this case, an estimate will be submitted before making such repairs.

Electro Scientific Industries, Inc. reserves the right to make changes in design at any time without incurring obligation to modify units previously purchased.

Electro Scientific Industries

7524 S. W. Macadam Avenue • Portland 19, Oregon

ESI instruments are carefully engineered and made to the most exacting standards of workmanship and accuracy in a modern and well-equipped factory.

Field Engineers are maintained in principal cities as a service to our customers. Customers are invited to contact our nearest field engineer or to consult our engineering staff for further information regarding ESI instruments and their applications.

SECTION I
GENERAL DESCRIPTION

1-1 GENERAL

The Model 425A DC Microvolt-Ammeter is an extremely sensitive measuring device which measures voltages from 1 microvolt to 1 volt and currents from 1 picoampere to 3 milliamperes. An input resistance of 1 megohm on all voltage ranges minimizes errors due to circuit loading.

The 425A can make measurements in circuits which are off ground potential, for the chassis and input circuit may be isolated from the cabinet.

The 425A provides an output which will drive either potentiometer or galvanometer recorders. It will deliver up to 1 milliampere at 1 volt.

1-2 APPLICATIONS

The 425A has many applications. For example, in engineering: it is an excellent null detector or dc amplifier, and it will measure vacuum tube grid currents and leakage currents in insulators and capacitors; in medicine and biology: it will measure nerve potentials and plant cell potentials; and in physics and chemistry: the 425A is useful in ionization chamber measurements and can monitor thermocouple and galvanic actions.

1-3 NOISE

Noise in the 425A, is less than 0.2 microvolts rms referred to the input. Due to the random nature of noise, its magnitude is best expressed in terms of its rms value. Peak-to-peak value of the type of noise in the 425A is approximately six times the corresponding rms value. Peak-to-peak noise in a typical 425A, as indicated by the meter, is approximately 1 microvolt referred to the input.

1-4 230-VOLT OPERATION

The 425A is normally wired for use from a 115-volt, 60 cps power supply, but it can easily be converted for use from a 230-volt, 60 cps source by changing the dual 115-volt primary windings of the power transformer from a parallel combination to a series combination. At the time of the change, replace the 1 ampere, slow-blow line fuse with a .5 ampere, slow-blow fuse. See the schematic diagram for details.

1-5 POWER SOURCE FREQUENCY STABILITY

The 425A uses an ac-coupled amplifier which is tuned to a frequency 5/6 designated power line frequency. A synchronous motor determines frequency of the signal applied to the amplifier. Thus the instrument must be operated from a power source which does not vary in frequency more than ± 5 cps. Most commercial power systems maintain frequency well within these limits; however, small portable power plants may not. Variations from designated power line frequency do not completely disable the instrument, but if large they will cause sluggish meter response and loss of accuracy.

1-6 50-CPS OPERATION

The 425A is normally shipped from the factory equipped to operate from a 60-cps power source. To convert it to operate from a 50-cps power source, you must change the rejection frequency of two twin-T filters from 50 cps to 41.7 cps. Both filters are contained in a single plug-in unit. Units designed to operate at 41.7 cps are available from the factory under stock number 9110-0039.

1-7 DAMAGE IN TRANSIT

Thoroughly inspect this instrument upon receipt. If there is any damage, see "Claim for Damage in Shipment" paragraph at the rear of this manual.

c. Set FUNCTION switch to desired function.

d. Set RANGE switch to desired range.

e. Clip probe and common clip together and adjust meter to zero with ZERO control. ZERO control has maximum range of about ±50 μv; thus it has diminishing effect on higher ranges.

NOTE

Do not handle the probe for three or four minutes prior to making zero adjustment on two most sensitive voltage and current ranges. Static charges and temperature gradients within the probe must have time to dissipate.

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f. Connect probe to circuit. On more sensitive ranges, allow sufficient time for probe, common clip, and circuit connection points to reach thermal equilibrium before considering reading final.

NOTE

Do not overload the instrument excessively on higher current ranges, for current-shunting resistors are not protected from extreme overload.

If 1 megohm input-shunting resistor is disconnected in your instrument, calibration of the nine lowest current ranges is altered. To use these ranges, either shunt instrument externally with a 1 megohm resistor or reconnect input-shunting resistor (see paragraph 4-10).

2-3 ISOLATING THE CHASSIS

To isolate chassis of the 425A, remove the metal shorting strap between chassis-ground and cabinet-ground terminals of OUTPUT connector located on rear of instrument. Potential difference between chassis and cabinet must not exceed 500 volts peak. Isolate chassis under following conditions:

a. Measurement is between two points which are both above ground potential.

b. Measurement is with respect to a ground which is itself isolated.

c. Measurement is made on a more sensitive range (precaution against ground currents).

2-4 OPERATION WITH A RECORDER

a. If conditions require isolation of 425A chassis, isolate recorder chassis.

b. Connect recorder to OUTPUT connector of 425A.

c. Clip probe and common clip together and select 1 VOLT range.

d. Set recorder zero to desired position on its scale.

e. Select 30 MICROVOLT range on 425A, and adjust ZERO control to produce end-scale deflection on meter (30 microvolts).

f. Calibrate system by adjusting output AMPLITUDE control to produce desired deflection on recorder.

g. Set meter of 425A to zero with ZERO control. The system is now ready to record your measurements. Remember that deflection of recorder is proportional to meter deflection of 425A regardless of range selected.

SECTION III
CIRCUIT DESCRIPTION

3-1 GENERAL

If the 425A is considered a black box with two input terminals and two output terminals, it is a dc amplifier. Block diagram of Figure 3-1 indicates what is between input and output terminals. The input signal is applied across the input resistance, and any ac superimposed on the signal is attenuated by the low-pass filter. A photoconductive modulator converts the filtered dc to a square wave whose frequency is set at 5/6 power-line frequency by a light-beam chopper. The output of the modulator is amplified by a high-gain, ac-coupled amplifier tuned to modulator frequency by feedback through a rejection-type filter. A synchronous demodulator, synchronized with the modulator by the light-beam chopper, converts amplifier output to dc. A second-rejection-type filter attenuates any remaining fundamental frequency component of the demodulator output. A dc cathode follower drives a meter, output circuit, and feedback attenuator which determines voltage gain of the instrument.

When operated as an ammeter, the 425A actually measures voltage drop across a calibrating input resistance. However, this resistance varies on all but five lowest ranges to keep full scale voltage drop across the input of the instrument to a maximum of 1 millivolt.

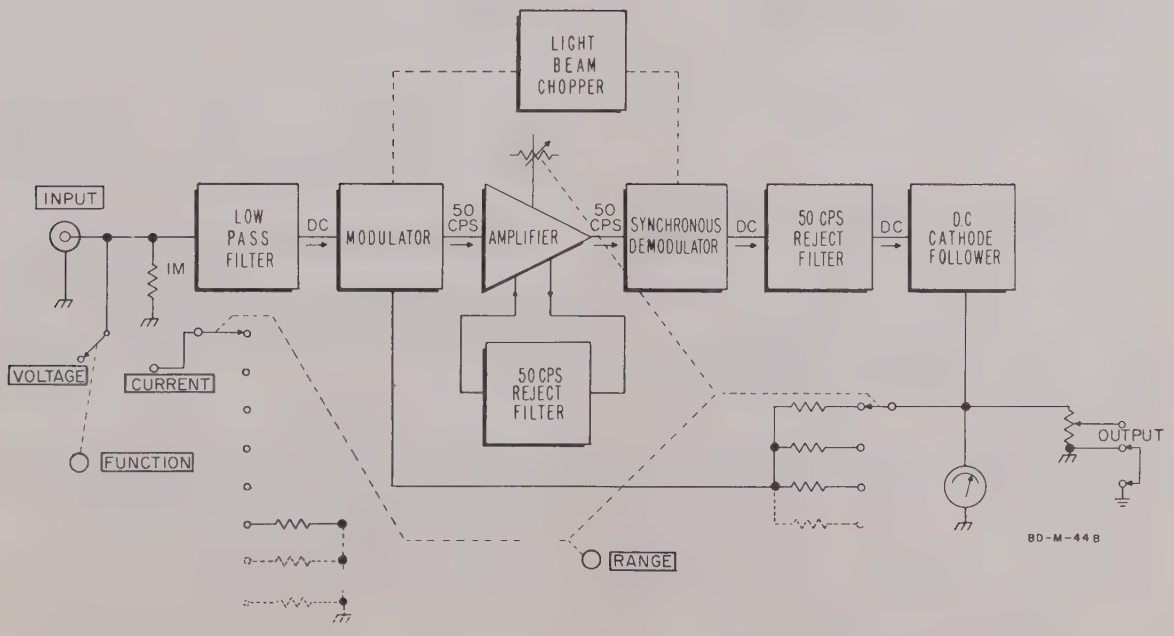


Figure 3-1. Block Diagram of 425A (power-line frequency = 60 cps).

Table 4-1. Trouble-Shooting

SYMPTOM	POSSIBLE CAUSE
Meter fails to respond to input signal, but responds to ZERO control.	Probe assembly defective. INPUT connector defective. Cable from INPUT connector to modular defective. Modulator assembly defective.
Meter fails to respond to either input signal or ZERO control, but responds to bias control.	V1 and/or V2 and/or V3 defective. Modulator assembly defective. Demodulator assembly defective.
Meter fails to respond to either input signal or ZERO control on one range only.	Contact on section D of RANGE switch defective.
Meter driven off negative end of scale.	Loss of B+. V3 heater open.
Meter driven off positive end of scale.	Grid-cathode short in V3B. V5 open.
Excessive noise indicated on meter.	V1 noisy. Poor contact between V1 pins and socket contacts. Noisy breakdown diode, CR1 or CR2.
Instrument operates normally except meter has slight zero offset on higher ranges, large switching transients on three lowest ranges.	Bias adjustment incorrect. R47 open.
Meter response very sluggish.	Weak amplifier tubes. Demodulator assembly defective. Chopper light misaligned.
Meter response to ZERO control limited to positive side of zero.	CR1 shorted.
On a particular range, meter drifts off zero with no input and instrument exhibits abnormally high sensitivity, but it operates normally on the two adjacent ranges.	Contact on Section A of RANGE switch defective. Corresponding range resistor open.

SECTION IV
MAINTENANCE

4-1 GENERAL

A certain amount of trouble-shooting of the 425A can be done visually. Observation of tube heaters, glow of the regulator tubes, incandescent lamps, and meter response to changes of various control and adjustment settings will generally reveal the area of the faulty component if not the component itself. Some symptoms and their possible causes are listed in Table 4-1, and a voltage-resistance chart is included in this section as a trouble-shooting aid in the event you do not find the faulty component visually.

The 425A is basically a simple instrument, and most troubles will be found with a minimum of effort. However, you might lose a great deal of time chasing down psuedo-troubles, particularly if they seem to appear on the most sensitive ranges. These troubles might appear as poor meter calibration, exaggerated zero drift, erroneous readings, etc. The 425A will measure accidental thermal voltages, voltages resulting from ground currents, and other stray voltages as well as the desired signal (see paragraphs 2-1 and 2-2). Therefore, check the 425A against a reliable voltage and/or current source under controlled conditions whenever questionable troubles occur.

4-2 MECHANICAL ADJUSTMENT OF METER ZERO

When meter is properly zero-set, pointer rests over the zero calibration mark on the meter scale when instrument is 1) at normal operating temperature, 2) in its normal operating position, and 3) turned off. Zero-set as follows to obtain best accuracy and mechanical stability:

a. Allow the instrument to operate for at least 20 minutes; this allows meter movement to reach normal operating temperature.

b. Turn instrument off and allow 30 seconds for all capacitors to discharge.

c. Rotate mechanical zero-adjustment screw clockwise until meter pointer is to left of zero and moving upscale toward zero.

d. Continue to rotate adjustment screw clockwise; stop when pointer is right on zero. If pointer overshoots zero, repeat steps c and d.

e. When pointer is exactly on zero, rotate adjustment screw approximately 15 degrees counter-clockwise. This is enough to free adjustment screw from the meter suspension. If pointer moves during this step you must repeat steps c through e.

4-3 PERIODIC CHECK OF CATHODE FOLLOWER BIAS ADJUSTMENT

Check cathode follower bias when you remove 425A from its shipping box. Thereafter, only an occasional check is necessary.

a. Turn instrument ON. Allow 15 minutes to warm-up.

b. Set FUNCTION switch to VOLTAGE.

c. Set RANGE switch to .003 MA.

d. Observe meter. If it reads approximately zero (±5% of end-scale) check is complete.

e. If meter does not read approximately zero, adjust R47, BIAS adjustment potentiometer located on rear of instrument, to approximately zero meter. Meter response to this adjustment is slow.

4-4 CABINET REMOVAL

a. Remove the two retaining screws located on rear of cabinet.

b. Slide instrument forward out of cabinet. Bezel ring remains attached to front panel.

4-5 CHECK OF MODULATOR ASSEMBLY

1. CHECK OF MODULATOR ACTION:

a. Remove instrument from cabinet.

b. Remove cover plate from input-circuit assembly.

c. Set FUNCTION switch to VOLTAGE.

d. Set RANGE switch to 1 MA.

e. Connect probe to a dc signal between 1 and 5 volts.

f. Connect an oscilloscope to point where C4 is connected to circuit board. Connect common lead of oscilloscope to inner chassis. See Fig. 4-2.

g. Energize 425A and observe modulator assembly output on oscilloscope. Figure 4-1 shows a typical waveform on oscilloscope having input impedance of 1 megohm. The waveform should have peak-to-peak amplitude approximately equal to test signal voltage and frequency 5/6 power-line frequency.

h. Disconnect test signal and oscilloscope. Replace cover of input-circuit assembly.

2. CHECK OF INPUT RESISTANCE:

a. Set FUNCTION switch to VOLTAGE.

b. Select a convenient voltage range and check meter zero.

c. Connect probe to a voltage which produces end-scale deflection of meter. Equivalent internal resistance of voltage source must be less than 1000 ohms.

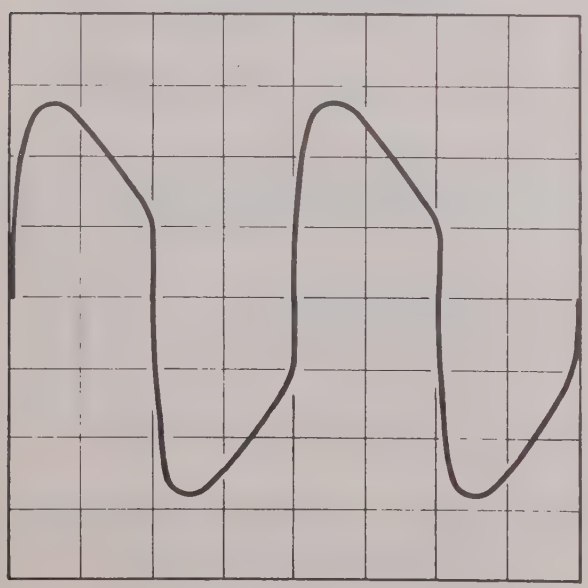


Figure 4-1. Modulator Assembly Output

d. Insert a resistor of know value between voltage source and probe.

e. Note reading on the meter. Determine input resistance of 425A from formula

$$Ri = \frac{Ei}{E - Ei} R,$$

in which Ri is internal resistance of 425A, E is voltage supplied by voltage source, Ei is voltage indicated by 425A with external resistor in series with voltage source, and R is resistance of external resistor. For example, if R = 1 megohm and Ei = 1/2 E, Ri - 1 megohm.

4-6 REPLACEMENT OF MODULATOR ASSEMBLY

Replace the modulator assembly as a unit; do not attempt to repair individual components. See Figure 4-2 and proceed as follows:

a. Disconnect C4 and leads from modulator assembly circuit board; they are connected to the board in the following order, starting from end closest to V1: brown, red, C4, orange, input and pink (to the same point), yellow, black, black, and black. (Note coded letters along edge of board.)

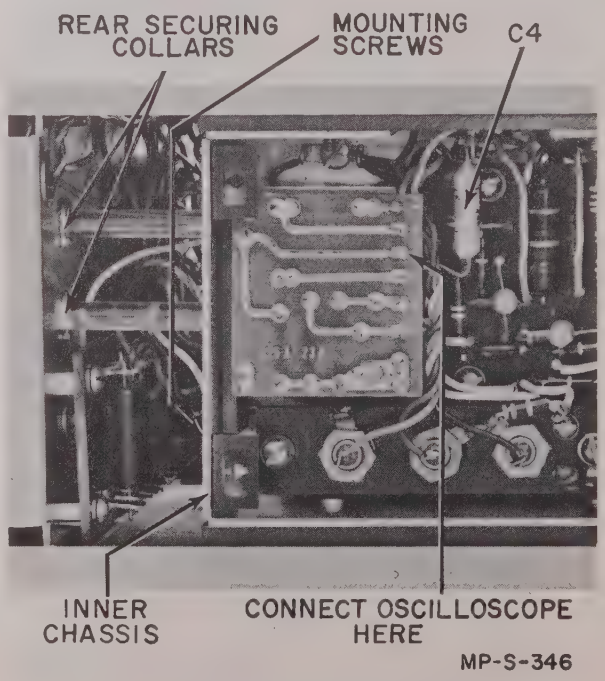


Figure 4-2. Modulator Assembly

b. Remove the two mounting screws which hold assembly in place. These screws are located above and below two plastic rods which enter input-circuit container from rear.

c. Carefully lift out the modulator assembly, Do not force it out, for the plastic rods may hinder its removal. If you must move the rods, spread their rear securing collars and slide them toward rear of instrument.

d. Place new assembly in position and secure it with the two mounting screws. Reposition the plastic rods if they were moved.

e. Connect external leads and C4 to assembly circuit board. Use only rosin-core solder.

NOTE

Use small soldering iron and apply minimum heat when soldering to the circuit board. Clean board carefully and thoroughly when finished. Be sure to remove all solder flux.

---

f. Check new modulator assembly as described in paragraph 4-5.

4-7 CHECK OF DEMODULATOR ASSEMBLY

a. Remove instrument from cabinet.

b. Locate demodulator assembly. It is mounted straight back from the RANGE switch above a resistor board (see figure 4-5).

c. Remove all leads connected to terminals of assembly. The leads are color-coded and connected to terminals in the following order; purple-white (one lead) to terminal farthest from main chassis blue-white (one lead) to middle terminal; and blue (one lead) to terminal nearest main chassis.

d. Connect a dc voltage between 1 and 5 volts across assembly (the two outer terminals).

e. Connect oscilloscope between middle terminal and either outer terminal. Oscilloscope must not present a dc path between its input terminals for this measurement.

f. Energize 425A and observe waveform on oscilloscope. Figure 4-1 shows a typical waveform on oscilloscope having input impedance of 1 megohm. Waveform should have peak-to-peak amplitude approximately equal to test signal voltage and frequency 5/6 power-line frequency.

4-8 ADJUSTMENT OF TWIN-T FILTERS

a. Remove instrument from cabinet.

b. The two filters are contained in a single plug-in unit which is held in place by two retaining screws located at the bottom of either side of unit. Remove unit.

c. Connect a harmonic-free sine wave whose frequency is exactly 5/6 power-line frequency between pins 6 and 8 of the plug base of unit.

d. Connect an oscilloscope or VTVM between pins 7 and 8 of plug base. Compare signal amplitude here with amplitude of the applied signal. If attenuation is approximately 60 db, check of this filter is complete.

e. If there is insufficient attenuation, remove U/shaped cover from unit. Two screws, one on each side secure cover.

f. Alternately adjust R39 and R41 (blue-colored controls) for minimum signal between pins 7 and 8 of base plug.

g. Connect test signal as described in step c between pins 3 and 8 of plug base.

h. Connect oscilloscope or voltmeter between pins 2 and 8 of plug base. Compare signal amplitude here with amplitude of applied signal. If attenuation is approximately 60 db, check of this filter is complete.

i. If there is insufficient attenuation, remove U/shaped cover from unit. Two screws, one on each side secure cover.

j. Alternately adjust R50 and R52 (red-colored controls) for a minimum signal between pins 7 and 8.

4-9 DISCONNECTING INPUT-SHUNTING RESISTOR

On special order, the 425A will be shipped from factory with 1 megohm input-shunting resistor disconnected from the circuit. Input resistance of the modified instrument exceeds 100 megohms on all voltage ranges. Modification can be performed in the field.

NOTE

Calibration of the nine lowest current ranges of modified instrument is altered unless you externally shunt the input with a 1.00 megohm resistor.

Proceed as follows:

a. Remove instrument from cabinet.

b. Remove the cover plate from input-circuit assembly.

c. See Figure 4-3 and locate indicated conductor strip on modulator assembly circuit board. Note that the strip is located between two leads coming from underside of board.

d. Cut the narrow conducting strip at each end. Do not cut into broader section of the conducting material immediately around leads. Use sharp cutting tool such as razor blade.

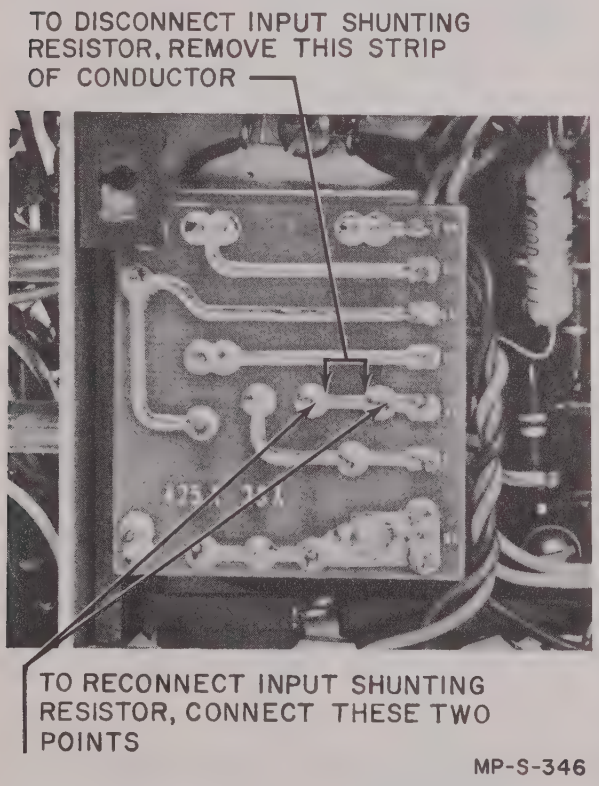

TO DISCONNECT INPUT SHUNTING RESISTOR, REMOVE THIS STRIP OF CONDUCTOR
TO RECONNECT INPUT SHUNTING RESISTOR, CONNECT THESE TWO POINTS
MP-S-346

Figure 4-3. Connection Point of Input-Shunting Resistor

e. Lift out the narrow strip of conducting material. Be careful not to lift any of remaining conducting material off board.

4-10 REPLACEMENT OF INPUT-SHUNTING RESISTOR

The input-shunting resistor remains physically in instrument when modification is made, whether at the factory or in the field. Therefore, the instrument can be restored to standard model at any time. Proceed as follows:

a. Remove instrument from cabinet.

b. Remove the cover plate from input-circuit assembly.

c. See Figure 4-3 and locate indicated points on modulator assembly circuit board.

d. Connect these two points with a piece of copper wire. Solder both ends neatly, using only rosin-core solder.

NOTE

Use a small soldering iron and apply a minimum of heat when soldering to the circuit board. Clean board carefully and thoroughly when finished. Be sure to remove all solder flux.

4-11 METER CALIBRATION

a. Set mechanical adjustment of meter zero (see paragraph 4-2).

b. Turn instrument on. Allow 15 minutes warm-up.

c. Check cathode follower bias adjustment (see paragraph 4-3).

d. Set FUNCTION switch to VOLTAGE.

e. Set RANGE switch to 1 volt range.

f. Connect probe to 1 volt ±1% dc source.

g. Adjust R67, METER CAL to set meter pointer to exactly 1.0. R67 is located just behind meter on the chassis.

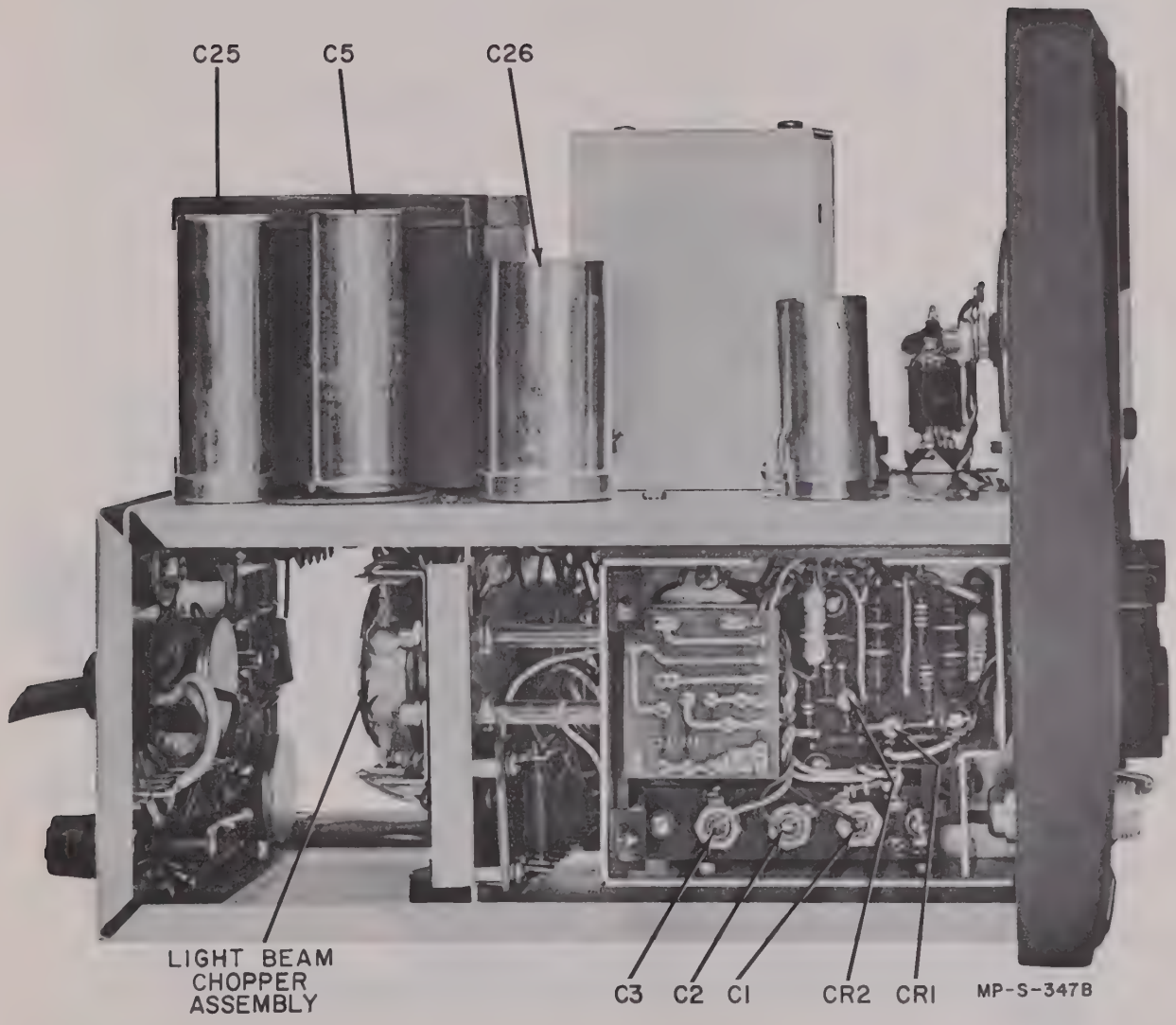


Figure 4-4. Left Side View of Model 425A

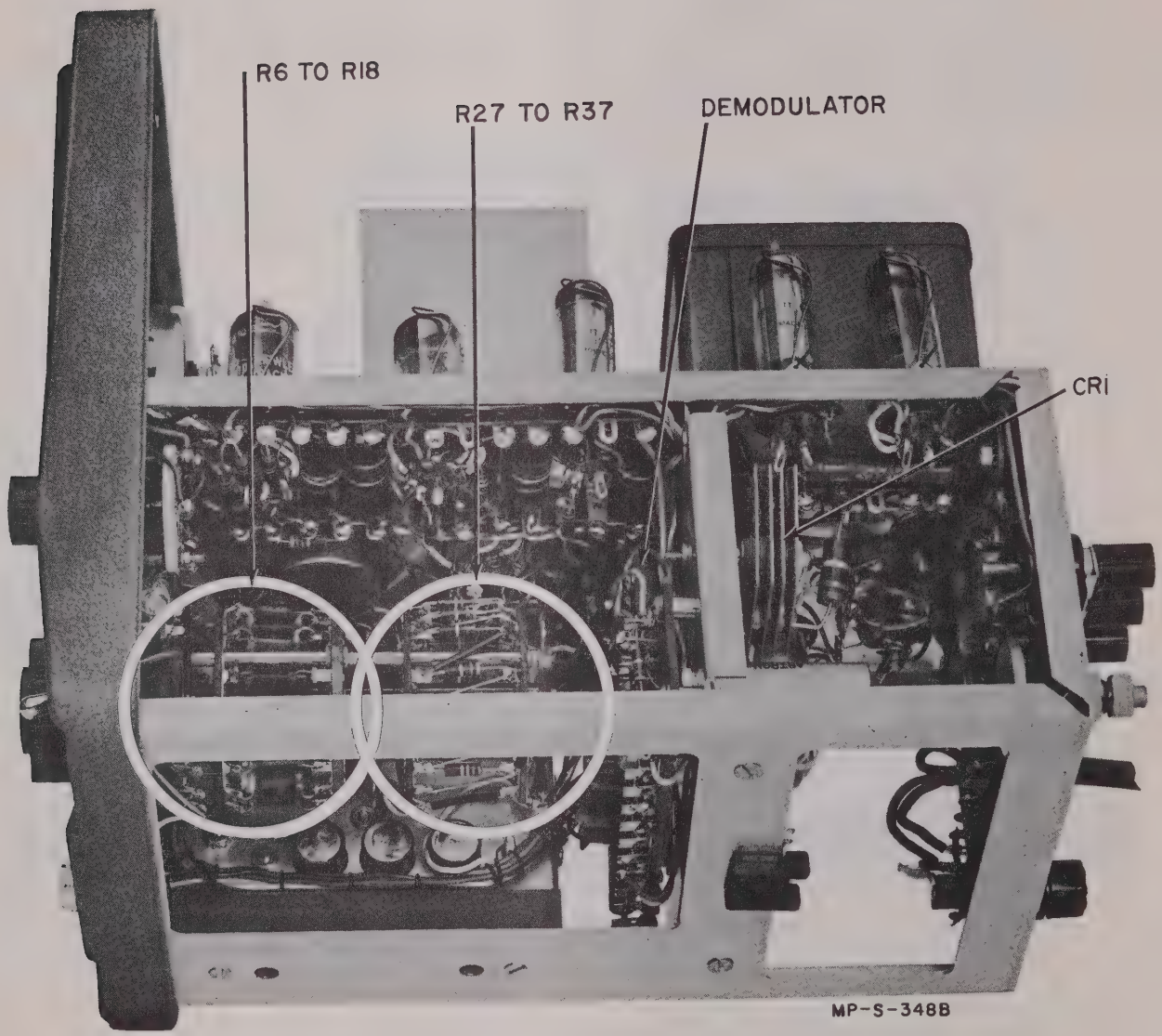


Figure 4-5. Lower Right Side View of Model 425A

SCHEMATIC DIAGRAM NOTES

1. Heavy solid line shows main signal path; heavy dashed line shows control, secondary signal, or feedback path.

2. Heavy box indicates front-panel engraving; light box indicates chassis marking.

3. Arrows on potentiometers indicate clockwise rotation as viewed from the round shaft end, counter-clockwise from the rectangular shaft end.

4. Resistance values in ohms, inductance in microhenries, and capacitance in micromicrofarads unless otherwise specified.

5. Rotary switch schematics are electrical representations; for exact switching details refer to the switch assembly drawings.

6. Relays shown in condition prevailing during normal instrument operation.

7. ‡ indicates a selected part. See parts list.

8. Interconnecting parts and assemblies are shown on cable diagram.

9. * Value adjusted at factory. Part may be omitted.

VOLTAGE AND RESISTANCE DIAGRAM NOTES

1. Each tube socket terminal is numbered and lettered to indicate the tube element and pin number, as follows:

*	=	no tube element	P	=	plate
H	=	heater	T	=	target (plate)
K	=	cathode	R	=	reflector or repeller
G	=	control grid	A	=	anode (plate)
Sc	=	screen grid	S	=	spade
Sp	=	suppressor grid	Sh	=	shield
Hm	=	heater mid-tap	NC	=	no external connection to socket
IS	=	internal shield	Δ	=	indefinite reading due to circuit (see 2.)

The numerical subscript to tube-element designators indicates the section of a multiple-section tube; the letter subscript to tube-element designators indicates the functional difference between like elements in the same tube section, such as t for triode and p for pentode.

A socket terminal with an asterisk may be used as a tie point and may have a voltage and resistance shown.

2. Voltages values shown are for guidance; values may vary from those shown due to tube aging or normal differences between instruments. Resistance values may vary considerably from those shown when the circuit contains potentiometers, crystal diodes, or electrolytic capacitors.

3. Voltage measured at the terminal is shown above the line, resistance below the line; measurements made with an electronic multimeter, from terminal to chassis ground unless otherwise noted.

4. A solid line between socket terminals indicates a connection external to the tube between the terminals; a dotted line between terminals indicates a connection inside the tube. Voltage and resistance are given at only one of the two joined terminals.

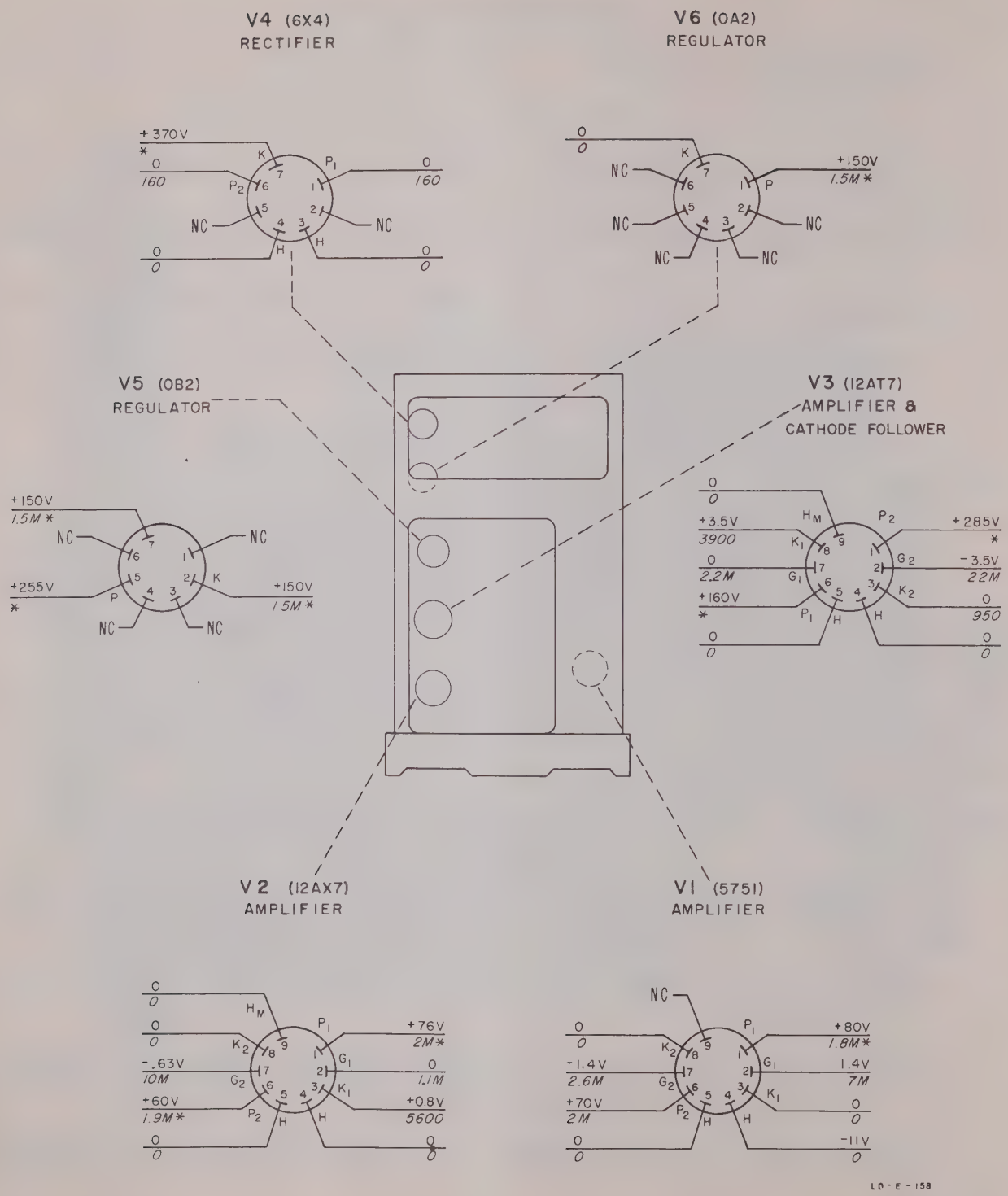
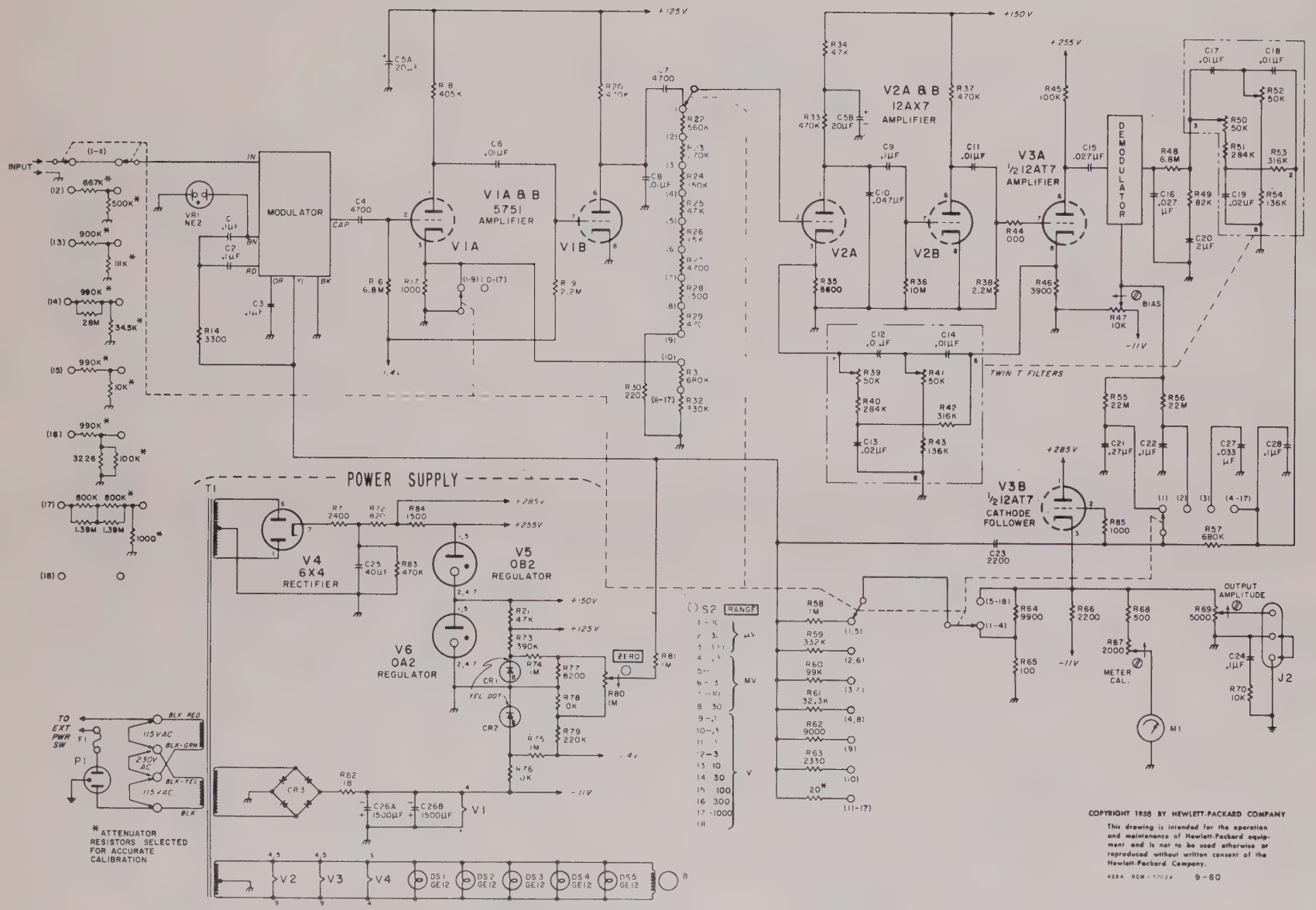


Figure 4-6. Voltage and Resistance Diagram (Viewed from Bottom)



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425A 0CM-T002A 9-60

SPECIFICATION HO7 425A DC VOLTMETER

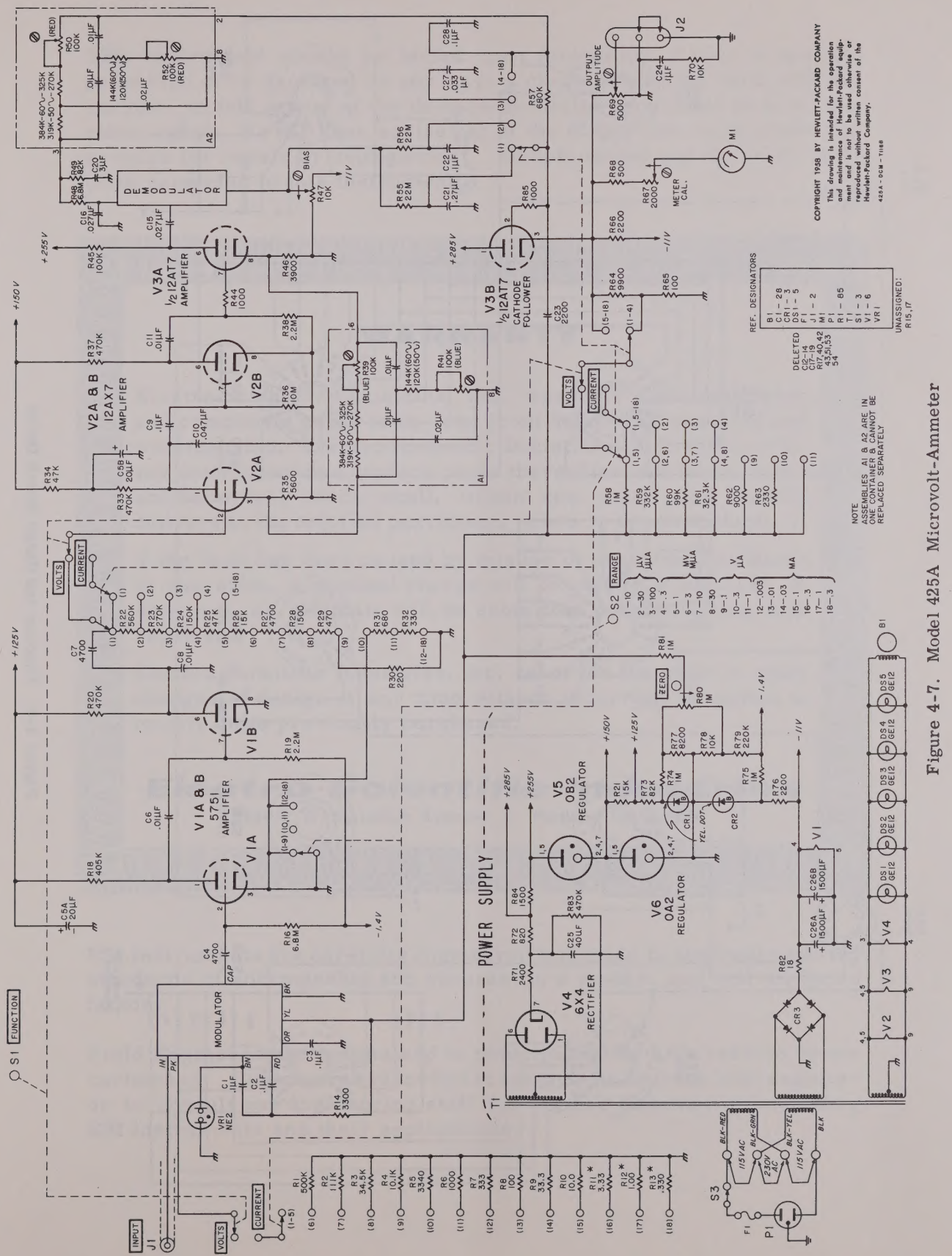

Figure 4-7. Model 425A Microvolt-Ammeter

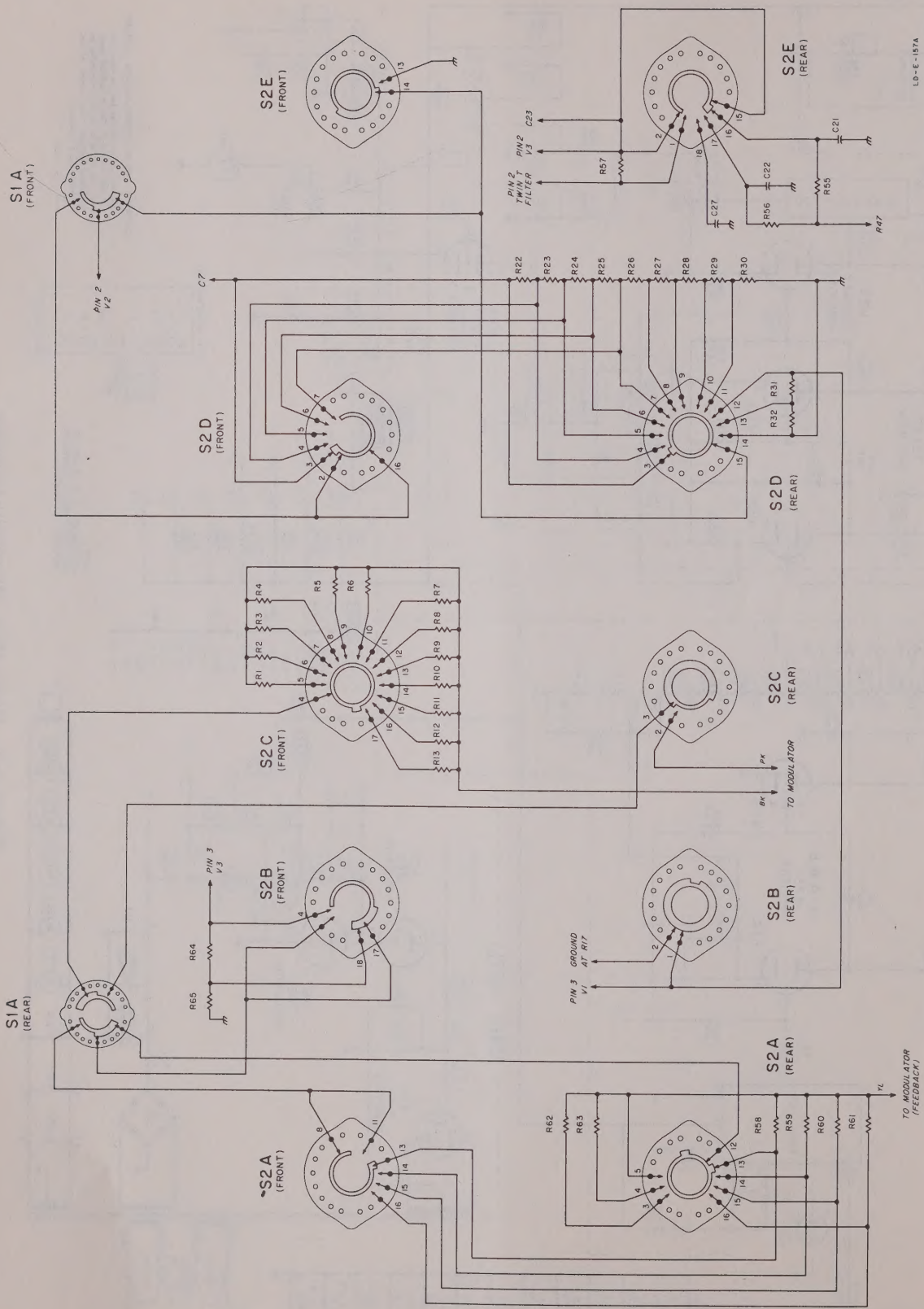

Figure 4-8. Function and Range Switch Detail

CLAIM FOR DAMAGE IN SHIPMENT

This instrument should be tested upon receipt. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be forwarded to us by the claim agent. We will then advise you of the disposition to be made and arrange for repair or replacement. Include model and serial number when referring to this instrument.

WARRANTY

Electro Scientific Industries, Inc. warrants each instrument and component parts to be free from defects in material and workmanship. Electro Scientific Industries, Inc. will service any instrument and replace parts thereof (except tubes, fuses and batteries) which shall, within one year after making delivery to the original purchaser, prove to be unsatisfactory.

If the fault has been caused by misuse or abnormal conditions or operation, a nominal charge will be made for repairs. In this case, an estimate will be submitted before making such repairs.

Electro Scientific Industries, Inc. reserves the right to make changes in design at any time without incurring obligation to modify units previously purchased.

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